Integration of Various Emotion Eliciting Factors for Life-like Agents

Kwanyong Lee

Dept. of Computer Science, Yonsei University

134 Shinchon-dong, Seodaemun-ku, Seoul, KOREA

kylee@csai.yonsei.ac.kr

ABSTRACT

A variety of works on building and adapting life-like agents for human-computer communication have been conducting. An important aspect we should consider when designing an agent is that how it is regarded by users. Through the appropriate mechanisms we should permit the users' suspension of disbelief for agents and give users the conviction that they can communicate with a computer efficiently and friendly by intervention of agents. We present here some preliminary works, a generalized and extended framework for the generation of emotions in anthropomorphic agents. A basic idea of the model is placed on the cognitive appraisal model, but it is extended to include other emotion eliciting factors, which are conventionally accepted that they are closely related to the generation of emotions. By representing the structure of the cognitive theory as a simple weighted network, the method provides a flexible way of modeling different aspects of personalities and temperaments.

Keywords

Emotion generation, Lifelike agents, Emotion eliciting factors

1. INTRODUCTION

The existing interface methods, which display the necessary information on the screen by using such the components as icons, buttons, and sliders, and ask users to manipulate them by a mouse or a keyboard under their responsibility, have been developed for about a couple of decades before and used as a major interface method so far. These methods may be efficient for programmers and developers with specialized knowledge about a computer and its manipulation, but it is obvious that users with less knowledge and experience have a feeling of inconvenience for the use of computers. As you may know, the environment of computer use and the requirements of users have been becoming more and more complex and dynamic; the general utilization of web browsers, the broadened class of users, and the increase of simple users without computer expertise. In these situations, agent-based interface has been placed lots of attention as an alternative approach to communicate between human and computer.

An important aspect we should not miss when building an agent system to interact with users is that the users' belief on an agent, that is, whether they regard it as a partner, an assistant, or a supporter, or just a machine or a program. Probably most of users want to communicate with something like a real agent, not a program. It is no doubt that an agent should process the assigned tasks effectively and efficiently. Moreover it is required that an agent should offer high believability and friendliness to users. In other words, the interface technology is demanding to permit the suspension of disbelief to users and thus provide the illusion of life that they are now communicating with a real agent not a computer.

To improve the users' belief in agents, a number of methods have been developed and exploited in current systems. Among them, there are the methods which make characters and their presentations more realistic by using various techniques of CG and animation, and the methods based on the interactive agents with multi-modal I/O channels like speech, facial expressions, and gestures.

On the other hand, emotion may be regarded as an essential part of our communication in real world. During conversation with a person, we try to grasp the emotional status of the opposite person from the clues such as his/her facial expressions and the vocal features as well as the contextual meaning of dialogue so as to proceed more natural communication through these information. From this point of view, there have been some attempts to apply the motional factors to anthropomorphic agents[1,3,4,6,7]. Some researchers believe that agents with the emotional function facilitate anthropomorphic view or improve the believability.

This paper describes some preliminary works on the generation of emotions for life-like agents. It focuses on an extensible and generalized framework, which can include a variety of emotion eliciting factors and present distinctive personalities and temperaments of agents.

2. REVIEW OF RELATED WORKS

All Researches on applying human-like emotional mechanisms to the areas of synthetic agents have been started actively from the beginning of 1990's. Most of these works are based on the theoretical, cognition-based model, called cognitive appraisal theory of Ortony, Collins, and Clore (hereafter, the OCC model)[5]. Thus we can classify the existing works into two groups according to the basis model; the works based on the OCC model[1,6,7] and others[4].

Because the OCC model has strong theoretical background on explaining the generation of emotions and computing their intensities, and has the simple structure enough to implement in ease, it has been becoming popular with many researchers. It converts an emotion eliciting situation into the conditions for emotion generation just by interpreting the situation in the cognitive level, thus what emotion it will be generated depends on the result of the interpretation of a given situation. On the contrary, there is a shortcoming that other factors except the cognitive interpretation of emotion eliciting situations are not considered in the model.

According to Izard's work[2], however, the emotion elicitors can be divided into 4 categories, and they include not only the cognitive elicitors similar to those of the OCC model but also the noncognitive elicitors such as facial expressions, body postures, emotions, mood, and drives. Velasquez's work[4] actually dealt with various elicitors mentioned in Izard's work. It should be noted that the decision on which basis model will be used or what kinds of elicitors will be included may be varied according to the specific purpose and the characteristics for which each method was designed.

Most of theories on the generation of emotions, of course, placed their focus on the cognitive elicitors. However, we should not overlook that there are a lot of factors, which directly or indirectly influence the generation of emotions, although some of them do not have any theoretical background. To build more believable and social life-like agents, it is necessary to exploit some of the noncognitive elicitors that are well known as the factors closely related to emotion generation.

3. COGNITIVE CONSTRUAL OF EMOTION GENERATION

A basic idea of cognitive appraisal theory proposed by Ortony et al.[5] is that each emotion eliciting situation is assigned to different conditions according to the construal of each agent. Accordingly, what emotion it will be generated entirely depends on the evaluation or interpretation of the situation, thus although the eliciting situation and conditions are the same, the different emotions can be generated.

In this model, emotion can be classified into three classes according to reactions to what, that is, events, agents, and objects. Each class can be differentiated into some groups of emotion types. An emotion type, here, means a collection of individual emotions with similar emotion eliciting conditions. Individual emotions within a specific emotion type can be distinguished from others by their intensities and so on. The emotion type *joy*, for instance, includes individual emotions, such as *happy*, *cheerful*, *delighted*, *ecstatic* and *joyful*. Some of the emotion types are constructed by combining other two emotion types. Twenty-two emotion types are modeled. The construal of emotion eliciting situation is carried out by assessing the three types of reaction with the global variables; the desirability of some events, the praiseworthiness of some acts and the attractiveness of some objects.

As explained in the previous section, the approach to provide the illusion of life simply by the OCC model to life-like agents may have some weak points intrinsically that it can not deal with the noncognitive factors although it has a good theoretical background, and that it is not easy to realize distinctive personalities by differences in expressing emotions.

In this paper, we, consequently, present an implementation strategy of the OCC model to accommodate a number of emotion eliciting factors which are not mentioned in the theory, and to express the distinctive personalities by controlling various parameters.

4. PROPOSED MODEL OF EMOTION GENERATION

4.1 Overall Structure

The main characteristics of the proposed model is that it is designed to deal with a variety of noncognitive factors as well as the cognitive factors which were proposed in the OCC model. In addition, the model can provide system designers with high flexibility so that each individual agent can have distinctive patterns of emotions and behaviors.

The OCC model can be easily implemented by the rule-based approach, but we represent it as the simple form of a weighted network, which is composed of lots of excitatory

or inhibitory connections between the factors and the emotion types, to accommodate all kinds of elicitors and offer a flexible way of representing different personalities of agents. Fig.1 illustrates the conceptual structure of the emotion generation module. For a given situation, each factor is graded as an appropriate value by using fuzzy inference. A weighted network receives the values of emotion eliciting factors as an input vector and calculates the intensities of each emotion type through the connections. Once the intensity goes above a threshold, the corresponding emotion is activated.

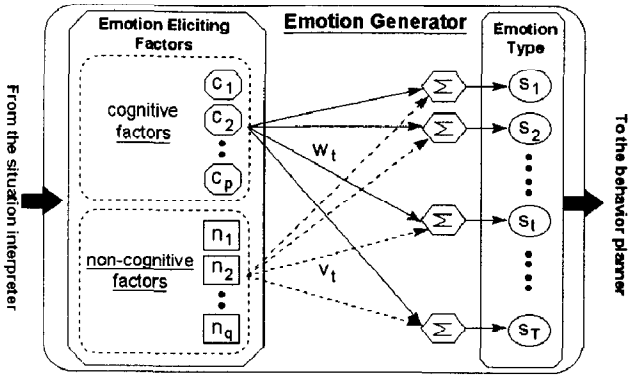

Figure 1. Structure of emotion generator

By exploiting this structure, we can also represent the phenomena, multiple emotions or mixed emotions that several different emotions at the same time can be generated from a situation.

4.2 Emotion Eliciting Factors

The eliciting factors can be classified into two groups as illustrated in the above figure - the factors, what we call the cognitive factors that are required for cognitive construal by the OCC model and the noncognitive factors.

Cognitive Factors : the following factors, in this model, are considered to generate emotions by the OCC model.

· *Importance of goals* : As explained in [6], the importance of goals has two components; one is the degree that a goal must succeed and the other is the degree that a goal must not fail.

· *Likelihood of goal success and failure* : These are used to keep the dynamic information of goal processing, and generate the prospect-based emotion types.

· *Goal success and failure* : The factor indicates that whether the current goal succeed or not and the degree of success or failure.

· *Desirability to other* : It means that how happy the agent is believed to be when the current goal is related to other, not self.

· *Importance of standards* : Like the importance of goal, the standard importance can be also divided into two parts; standards that must be met and standards that must not be broken.

· *Degree to which self/other is held to be responsible* : The factors indicates that who has the responsibility for that action and the degree of responsibility.

· *Strength of the attitude to objects or other agents* : This means how much the agent like or dislike an object or other agent.

In many cases, the information of the importance/strength of goals, standards, and attributes is fetched from the pre-stored information. Each factor can be, on the whole, broken down into a positive aspect and a negative aspect. The positive factors have the strong connections with the positive emotion types to excite them. On the contrary, the negative factors connect with the negative emotion types by the inhibitory connections.

Noncognitive Factors : in this model, they indicate all of the factors that are not handled in the OCC model.

· *Facial expressions, mood, and body postures* : These factors are said to be closely related to the generation of emotions. For example, other's smiling makes me happier, and people rarely get angry when he/she is in a good mood.

· *Current emotions and drives* : They act as excitatory or inhibitory components for the emotions to be generated, and also can generate emotions when they are exploited by themselves. Through the mechanism that the current outputs of emotions are fed into the emotion generator again, we can get the same emotions with less intensity. By doing so, we can easily model the decay rate of emotions, and express the different decay rates according to the external stimuli and environmental conditions.

· *Emotional memory* : To retrospect on the old days can generate emotions. Thus, it keeps the information of the status of the emotion generator in the memory modules when much stronger emotion than others is generated. Also it can serve as the excitatory or inhibitory connections for upcoming emotions.

4.3 Calculation of Emotion Intensity

The intensity S_t of emotion type t is formulated by the following equation.

$$S_t = \varepsilon_t \phi_t(c) + (1-\varepsilon_t)\varphi_t(n)$$

$$\phi_t(c) = \sum_i w_i \cdot c_i$$

$$\varphi_t(n) = \sum_i v_i \cdot f_i(n_i)$$

In the methods based on the OCC model, in principle, the cognitive factors **c** may have more influences on the generation of emotions than the noncognitive factors **n**. Therefore, we use the parameter ε_t to control the relative importance of the cognitive factors upon the noncognitive factors. The final intensity of each emotion type is represented by the sum of the intensity of the cognitive factors and the intensity of the noncognitive factors. The intensities of emotions affected by the cognitive factors are computed by the sum of the product of their inputs and the corresponding weights. However, since the noncognitive factors may vary in the degree of influence on emotions and the way they are applied, we use the different functions according to the factors. Therefore, the function f_i for each factor n_i are appropriately defined and exploited respectively. The intensities of emotions related to the noncognitive factors are obtained by applying f_i to n_i and then calculating the sum of the product of the converted input values and their weights. Once the final intensity goes beyond a threshold, the corresponding emotion type is activated.

4.4 Control of Personality

To support a flexible way of controlling and representing the distinctive personalities and temperaments, various parameters such as the activation thresholds, the weights of the network, and the functions for the noncognitive factors are used in this model. By adjusting these parameters, we represent the different patterns of emotions that can be characterized as the different personalities.

5. SIMULATION

We conducted the experiment to evaluate the proposed approach to the generation of emotions. The method is applied to the model for a social relationship between a teacher and three students with distinctive personalities. We selected a number of situations that can be occurred in the classroom and offered them to the system as the specific inputs to see whether it generates appropriate emotions. To evaluate the effectiveness of the noncognitive factors, we compared the emotions generated only by the cognitive factors with the emotions generated by both the noncognitive factors mentioned in this model and the cognitive factors. The experiment showed that the use of the noncognitive factors contributed effectively toward increasing the believability of the agents, and that it was easy to generate various patterns of personalities simply by changing the parameters.

6. CONCLUSIONS

As a part of constructing a life-like agent with more believability through the emotional interaction, we presented more generalized and extended framework for the generation of emotions. We extended and generalized the OCC model, which is based on the cognitive construal of a situation for the generation of emotions, to contain the noncognitive elicitors, which are asserted to be related to the generation, such as current emotions and drives, facial expressions, mood, and emotional memory. By representing the cognitive appraisal theory as the form of a weighted network, we can also offer the distinctive personalities of agents through the adjustment of parameters. We applied the method to a social relationship between a teacher and students for intelligent tutoring system. Simulation results showed that this approach to improve the believability of anthropomorphic agent is effective.

Our future work can be summarized into two things. One is to quantitatively analyze the distinctive personalities expressed by the parameters so as to determine the parameter settings for the representative personalities. The other is generating a representative emotion type from several emotion types with different intensities.

7. REFERENCES

[1] Clark Elliott, The Affective Reasoner: A process model of emotion in a multi-agent system, Ph.D dissertation, Northwestern University, 1992

[2] Izard C.E., Four Systems for Emotion Activation: Cognitive and Noncognitive Processes, Psychological Review, 100(1), pp.68-90, 1993

[3] Joseph Bates, The Role of Emotion in Believable Agents, Communication of the ACM, 37(7), pp.122-125, 1994

[4] Juan D. Velasquez, Modeling Emotions and Other Motivations in Synthetic Agents, Proc. of AAAI-97, pp.10-15, 1997

[5] A. Ortony, G. Clore, and A. Collins, The Cognitive Structure of Emotions, Cambridge University Press, 1988

[6] W. Scott Reilly and Joseph Bates, Building Emotional Agents, Technical Report CMU-CS-92-143, Carnegie Mellon University, 1992

[7] H.Ushida, Y.Hirayama, H.Nakajima, Emotion Model for Life-like Agent and Its Evaluation, Proc. of AAAI-98, pp.62-69, 1998